Trace Elements in Ground Waters of the United States: A New Statistical Summary

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Biographical Sketches of Authors

Lopaka (Rob) Lee is a research geologist with the USGS Mineral Resources Program in Denver, Colorado. He holds an M.E. in Geological Engineering from the Colorado School of Mines and specializes in environmental geochemistry. Lopaka currently works on variety of projects integrating field-based observations with predictive geochemical modeling and data analysis. Since 2000 he has served as a technical advisor to private industry and government planning committees on the environmental impacts of mining Mississippi Valley Type Pb-Zn deposits in the U.S. Mid-continent. Lopaka is the author and maintainer of WatRes, a free water-resources statistics library for use in the R and S-Plus statistical computing environments.

Dennis Helsel is a research geologist with the U.S. Geological Survey in Denver, Colorado. He holds a Ph.D. in Environmental Sciences and Engineering from Virginia Tech, and his current research focus is on interpretation of censored environmental data. His textbook *Statistical Methods in Water Resources*, originally published in 1992 and now republished by the US Geological Survey, is considered a standard tool in the water resources community. Dr. Helsel is a longtime member of the American Statistical Association, and has published in a wide variety of journals, from methods papers in Environmetrics to national summaries of arsenic in ground waters in the journal Ground Water. His varied interests center on improving the practice of interpreting environmental data. His new textbook *Nondetects And Data Analysis* will be published by John Wiley in 2004.

Abstract

Accurately defining statistical distributions of trace elements in ground water for a region as large and diverse as the United States is a formidable task. This study provides statistical models of the concentrations of trace elements in ground waters of the U.S. using data generated by the National Water Quality Assessment (NAWQA) Program of the U. S. Geological Survey (USGS). The NAWQA Program provides a consistent sampling and analytical framework that produces water-quality information representative of the majority of ground waters used for public consumption throughout the country.

Our analysis uses new, publicly-available software developed for this study, designed for data sets with multiple detection limits. These methods are necessary to correctly estimate statistics for multiply-censored data without introducing the bias or artificial signals possible when fabricating values for nondetects. Our methods also estimate the probabilities of exceedance for concentration limits such as current or future water-quality standards. For example, the median concentration of dissolved arsenic in U.S. ground water is 0.7 ug/L. The current EPA MCL for Arsenic (10 ug/L) has a probability of exceedance of 7 percent. Alternative arsenic standards at 5 and 3 ug/L have exceedance probabilities of 15 and 25 percent respectively.

We compare our results to a similar study using data from USEPA's STORET, containing water-quality data collected from a variety of unrelated investigations. Our results corroborate results from that study for some elements, but for others we produce lower concentration statistics, presumably due to differences in site selection and design.